DRAFT REPORT

(251)

DEVELOPING, VALIDATING AND TESTING THE EFFICACY OF SELF-LEARNING PROCESS BASED MATERIAL FOR THE DEVELOPMENT OF SOME INTEGRATED PROCESS IN SCIENCE

AN ERIC PROJECT

PROJECT TEAM

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THE PROJECT

Science is taught through different approaches. These include concept approach, environmental approach, integrated approach and so on. In concept approach, a number of concepts and related topics are chosen for the learners and are included in the curriculum. Knowledge of concepts, it is thought, promotes understanding, develops one's capacity for application and improvisation. In the nevirionmental approach emphasis is on the intraction of man with his environment, and in comparing himself with other organisms.

During sixties American Association for Advancement of Science (AAAS) emphasized science processes under the project Science - A Process Approach (SAPA). Processes are considered 'mental tools' which enable the learner to acquire knowledge of science. The number of processes that have been identified to date are around 13. Important among these are, observing, classifying, inferring, predicting, interpretting, difining operationally, controlling variables, hypothesis-making and testing. That a child can be enable to develop these processes as 'mental tools' or 'skills' or 'abilities' is the basic assumption on which the present project was based. It is because the content of science is increasing fast, it would be necessary that a child is equipped with these abilities or tools of inquiry. It will be difficult for the child to master all the concepts of science. What will be important in future will be 'to develop in the child well defined abilities and values such as spirit o inquiry, creativity, objectivity, the courage to question and an aesthetic sensibility'. (NPE. 1986). It may, however, be noted that 'process-striven' approach has also been

viewed critically in certain quarters as 'emphasizing skill over knowledge' and schools..... teaching pupils how to think, without giving them anything to think about. Therefore, in the teaching of science both content and process has to be viewed in a balanced way so that children get training in the processes at the early stages of schooling and moving gradually towards coherent and connected units of knowledge.

The present project was undertaken to study the development of these abilities, or what may be called the processes, through the use of instructional materials prepared for the development of these processes. The processes chosen by the investigator for the present project included : (i) classifying, (ii) inferring, (iii) interpretting, (iv) precicting, (v) hypothesis-making and (vI) hypothesis-testing. The project was conducted in one school (Lindquist, 1970 in Design V) over a span of about two and half years on a student population of 125 students of class IX studying at Demonstration Multipurpose School (DMS), RCE, Bhopal and Bharti Niketan, BHEL. In a project of this type, certain students are bound to drop-out. Therefore the final analysis is based on the responses of 77 students. Pre and post test design was used to study the gains made in scores on science processes with the training imparted through instructional material based on the six processes. Gains were studied by using a test of integrated process in science (TIPS) developed under the project. Certain agencies and individuals have helped in the execution of the project. The investigator expresses her gratefulness to all these agencies, especially the financial support extended by the Educational Research

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INTRODUCTION

CHAPTER I

1.1 Science - A Process Versus Product Approach

In the beginning emphasis in science teaching was on the product rather than on the processes of science. As for content the concepts, principles and laws of science were emphasized in teaching. During the past twenty five years, curriculum development and instruction in science education has been influenced by Gagne's conception of science processes. Layton (1973) highlighted the unique characteristic of science as a branch of learning was the method by which knowledge was acquired (and that) the inductive aspect of scientific activity, rather than the conclusions, were of most significance from an educational point of view. Science was (to be) studied in the schools not for its informational benefits but because it trained the power of observation and reasoning.

For Gagne, scientific inquiry is the terminal objective of science education. He describes inquiry as "a set of activities characterised by a problem-solving approach in which each newly encountered phenomena becomes challenge for thinking. Such thinking begins with a careful set of systematic observations, proceeds to design the measurement required, clearly distinguishes between what is observed and what is inferred, invents interpretations which are under ideal circumstances brilliant leaps, but always teachable and draws reasonable conclusions" (Gagne, 1963, p.145) Gagne argued that the students must be able to make inductive inference and to judge when those inferences are valid. These capabilities are dependent upon students having learned a great-deal of conceptual knowledge, including

broad generaliseable principles and the constituent concepts of those principles. Knowing a principle implies being able to use it to describe a wide variety of situations.

Gagne says that pre-requisite knowledge of concepts and principles can be obtained only if the students have underlying capabilities, that is the science processes, which are needed to practise and understand science. The processes are hierarchically organised with the ability to use each upper level processes dependent on the ability to use the simple underlying processes. Observation is considered to be the fundamental skill by virtue of its position at the foundation of the hierarchy of skills needed to discover the broad knowledge required to conduct inquiry.

The other major features of the processes are :

1. Each process is a specific intellectual skill used by all scientists and applicable to understand any phenomena.
2. Each process is an identifiable behaviour of scientists that can be learned by students.
3. The processes are generaliseable (transferable) across content domains and contributes to rationale thinking in every day affairs. In simple words, it may be put that science processes are the foundations for scientific inquiry. They are generaliseable intellectual skills needed to learn the concepts and broad principles used in making valid inductive inference.

Empirical literature from other countries exploring such diverse scientific reasoning abilities as (a) control of variables (Kuplan & Phelps, 1979; Levine & Linn, 1977); (b) probabilist reasoning (Tverskey & Kahnemah, 1974); induction of generalisation from data (Bourne & O'Banion, 1977); (c) deduction of conclusions from premises (Staudenmayer & Bourne, 1977); (d) comprehension of causal relations (Divitto McArthur, 1978); (e) generation of hypotheses (Pouler & Wright, 1980); (f) the effect of casuality, response alternatives and context continuity on hypothesis-testing reasoning (Lawson, 1983); (g) discovery of cause-effect relationships by children (Rudnitsky, Hunt, 1986); (h) and the effect of self-paced instructional materials upon the acquisition and retention of integrated science process skills (Strawits, Malone, 1987) are available.

These studies underlie the need to organise learning experiences in such a manner where the students are exposed to the basic and integrated skills required in dealing with scientific knowledge. There have been continuous efforts to improve the teaching of science over the past three decades. The teaching and learning of science has undergone a change for the better during this period, all over the world. The traditional approach(learning of facts, information) has been replaced by the modern approach acquisition of concepts, processes). In the traiditional approach, which is also known as conceptual approach, the child is expected to learn concepts, principles, laws, names, numbers and other specific information. According to Callahan and Clark (1978). "The traditional programme, teacher and text-books were the major source of information

and the dispensers of knowledge, the lecture and a study-type of reading were the most common procedures. Questioning was strictly fact-based and often teacher initiated. The data was the uniform body of the facts every one was expected to master. The children were quite often, required to memorize the information.

The modern approach, emphasizes that isolated facts, unrelated to unifying concepts or themes or to meaningful application is of little value to the student. For example, in the teaching of solar system through the traditional approach, the children are made to learn some factual information such as the distance of earth from the sun (93 million miles), diameter of sun (8000 miles) and other facts related to the solar system. Whereas in the modern approach the emphasis is on inquiry skills.

The children observe the natural phenomena of sunlight, study its effects on various objects ~~xx~~ such as wall, floor, clothing and plants. They learn to record the temperature and discover that some of the things get hotter easily than others. Similarly, in an exercise on the movement of liquids in materials, the children learn to design and carry out experiments on the relationship between bands of material and rate of movement of liquids within them, including the control and manipulation of relevant variables; but they are not required to learn particular facts about the rate of required to learn particular facts about the rate of liquid movement in blotting paper, fabrics, sand clay or other materials used in these excercises. In this way the children manipulate the objects, observe the natural environment, formulate questions, varify the solutions and arrive at certain results themselves. Thus the content of science is

interwoven with concepts and the concepts are applied to the solution of problems by carrying out certain practical exercises. The process approach, therefore, refers to activities of experiments which must be carried out so as to arrive at the solution of problems on which science works. Callahan and Clark (1978) say, "Process depends first of all on the nature of the problem. If we are interested in finding out how heavy certain objects are, we weigh them. If we wanted to fit the objects into a container we would measure their sizes. Not all processes are used in any one investigation". (p.199)

This is not to suggest that the process approach is without criticism. It has come from certain quarters in the U.S.A. In a survey, undertaken by the National Endowment for the Humanities in 1987 with the help of 40 educational experts, it was pointed out that these exist among the high school students "startling gaps in their knowledge of even American history and literature." The answer to such a criticism could be start process approach, used first in science, could not be that much effective in humanities. However, with the keen competition among children of several countries, the pendulum seems to be swinging back in favour of the conceptional approach.

1.2 NATURE AND MEANING OF PROCESSES

There are a number of ways of understanding the meaning of "process" as exemplified in Science-A Process Approach (SAPA). First it may be understood that an emphasis on process implies a corresponding de-emphasis on the 'traditional content approach'. But it does not mean that the science content is not there.

This aspect is clarified by the American Association for the Advancement of Science (AAAS)

> "Actually, the science areas and concepts presented in the Process Approach are as comprehensive as any elementary science programme available. But after they have forgotten the bits and pieces of information derived from content, children using SAPA have developed and retained basic skills in the processes of science and this provides them with a systematic and logical way of thinking in approaching and solving problems. Content provides the means by which the children acquire and develop the processes of science. While scientific facts, laws, and theories are always subject to review and revision, the basic tools of science do not change" (p.3).

The content is there and the children examine and make explorations of solid objects, liquids, gases, plants, animals, rocks and even moon photographs. But the difference in approach is that they are not asked to learn and memorise particular facts or principles about these objects and phenomena. Rather, they are expected to learn such things as to how to use the skill of "observation' in watching the solid objects and their motions, how to classify liquids, how to infer internal mechanism of plants, how to make and verify hypotheses about animal behaviour and how to perform experiments with different hypotheses.

The skills which the S.A.P.A. is is designed to develop begins in highly specific and concrete forms, and increasing generality of these skills is systematically provided for by a planned progression of exercises.

Evidence shows that these skills do generalise to a variety of new situations. The instructional programme of Science - A Process Approach (SAPA) attempts to deal realistically with the development of intellectual skills in the sense that the goals to be achieved by any single exercise are modest. A long term substantial and general intellectual development is expected to result from the cumulative effects of an oderly progression of learning activities.

A second meaning of process, referred to by Gagne (1968), centres upon the idea that what is taught to children should resemble what scientists do, that is, the process that they carry out in their own scientific activities. Scientists observe, classify, measure, infer, make hypotheses and perform experiments. If scientists have learnt to collect information in these ways, the elementary forms of what they do can be learned by the children in the early classes.

Footnote

In India, this approach has been developed and implemented in a different way at Kishore Bharti, a village near Hoshangabad in Madhya Pradesh, since the early seventies. It is known as Hoshangabad Science Teaching Project (HSTP). The teaching and learning of science is stressed through process approach and there is much use of local environmental resources. The HSTP was, in the beginning a pilot project and is now expanded to almost all Regional of M.P. Another voluntary organisation, which has grown out of HSTP, is called Eklavya. It publishes 'Chakmak' children's science magazine. The objectives of this science publication are develop among the children the abilities of natural

expression, imagination, skill and thought. The objective of these organisations, both Indian and abroad, does not in any way mean that we are aiming at making every individual a scientist. Instead it puts forward the idea that the development of scientific creativity may be possible because students will be able to look upon and deal with the work in ways that the scientists do. Gagne calls them learned capabilities and intellectual skills. An ability to use the processes requires one to assimilate information, process that information and make an individual step beyond the basic information given. Gagne states that educational processes are not entitles of urbanization nor are they content processes, such as the processes of economics. Instead they are the strategies, the behavioural capabilities, the psychological processes used by the individual to deal with the content. The National Policy on Education-1986, accepted recently by the Parliament suggests that science education will develop in the child. "Well defined abilities and values such as the spirit of inquiry, creativity, objectivity, the courage to question and an aesthic sensibility" p.23.

The third and perhaps most widely accepted meaning of process introduces the consideration of intellectual development of children. From this point of view, the processes are in a broad sense ways of processing information. For example, the children may be asked to underline the largest figure out of; (1) 237, 343, 392, 264; (2) 2492, 2437, 2439, 2399 etc. Such processing grows more complex as the individual develops from early childhood onwards. The individual capabilities that are

developed may reasonably be called "intellectual skills"- a phrase which many would prefer to the term processes".

TYPES OF PROCESSES

Having known the nature and meaning of the processes let us know the different types of processes that are emphasized in the teaching of science especially at the elementary level. Eleven major processes identified at this level define science as : (i) observing; (ii) classifying; (iii) measuring; (iv) interpreting; (v) predicting; (vi) inferring; (vii) communicating; (viii) formulating questions; (ix) formulating models; (x) generalising; and (xi) experimenting.

The above listed processes, according to AAAS, place the student in an active and dynamic role of invertigating scientific phenomena-using the processes of th scientist. The SAPA was incorporated into the various curriculum study group projects which were initiated in the U.S.A. and other countries during the early sixties mainly because of two historic reasons. Firstly, it was due to the demand created by the first man-made Sputnik which was launched into the space and secondly "the demand coincided with an already existing drive to revise science curriculum in line with a new understanding of the child's intellectual development". These understandings were advanced by the researches of Jean Piaget, Robert Gagne, Jerome S.Bruner and other proponents of cognitive psychology. Many aspects of modern approach of teaching and learning of science such as the concepts of teaching, methods, materials and lessons were included in these projects. Callahan and Clark (1978) point out, "Although each project stressed different aspects of current science

teaching philosophy, they were all produced by teams consisting of scientists, elementary school teachers and education specialists. In workshop situations they wrote objectives and rationales, produced printed matter for pupils and teachers' guides and included laboratory experiences, multi-media materials and evaluative instruments. Summer institutes that focussed on techniques and goals trained hundreds of teachers, who then pilot-tested the programmes with thousands of children and worked closely with the writers to revise and expand the material" (p. 201).

This project was undertaken with the assumption that if we provide to the teachers and learners process-based study materials, their capacities on these processes can be enhanced considerably. Before, these materials were administered, a pre-testing of their performance in science by making use of the available ability processes was done. The gains in scores, after they have studied these materials, would thus be attributed to the efficacy of the materials.

3. OBJECTIVES OF THE PROJECT

The major objectives of undertaking this project were as follows :

1. To observe sample lessons of pupil teachers with a view to finding out the extent to which they use processes of science in the teaching of science.
2. To prepare self-learning process based materials for the development of some of the integrated processes of science. These include the processes of classifying, inferring, interpreting, predicting, hypothesis-making and testing.

3. To develop a test of integrated processes in science (TIPS) based on the above mentioned six integrated processes.
4. To administer self-learning instructional material on a sample of class IX students and to study the efficacy of self-learning process-based material.
5. To study the inter-relationships between the scores obtained from the process based test and the scores obtained in science attitude scale (SAS).
6. To study the differences in scores obtained on the science attitude scale by using appropriate techniques
7. To interpret the data obtained and work out the implications in terms of teaching methodology and use of instructional materials in science subjects.

4. OPERATIONAL PLAN

The above listed objectives of the project were realised through an operational plan drawn up for the purpose. This included :

1. Observation of science lessons of students with a view to determining the extent to which the prospective teachers emphasize the process approach.
2. Preparation of self-learning materials in science with a view to developing among the pupil teachers the processes under study, and
3. Developing a test of science processes which could be used to study the gaining in score on process skills of the pupil.

The next chapter deals with the related researches conducted on the various aspects of science processes.

CHAPTER II

BACKGROUND RESEARCHES

2.1 Introduction :

This chapter deals with the impact of process-based instructional material upon student and teacher performance. Some studies, conducted in the USA and other countries, are reviewed. The three science projects-ESS, SCIS and SAPA-had great impact on the quality of science teaching in the past three decades.

After the launching of SAPA curriculum, numerous studies having bearing on teaching concepts, teaching methods, philosophy, curricular materials, evaluation in terms of output of teachers and their pupils such as gains made in the cognitive and affective domains, were conducted. Summarised in this chapter are the findings of some studies that are related to the present project undertaken by the investigator. These studies, as such, have been dealt with under three broad titles namely, (a) impact upon students' achievements (b) impact of process-based and discovery-oriented instructional materials on pre-service and inservice teachers' performance and (c) impact of SAPA on science text books for the pupils.

Before these researches are reviewed it will proper to mention that the AAAS choose eight categories of processes (observing, classifying, using space/time, relations, using numbers, communicating, measuring, predicting, inferring) for use in lessons for grades K-3; and six categories of processes (formulating hypotheses, controlling variables, experimenting, defining operationally, formulating models, interpreting data) for grades 4 to 6. These processes were, however, modified for use in the secondary grades.

2.2 Instructional Material and Students' Performance on Process Based Tests

Wideen (1975) studied that competetive effectiveness of SAPA as compared to traditional science teaching on the basis of scores from cognitive process-oriented skills, interests, attitudes and classroom perception measures. The research was conducted on students studying from 3rd to 6th grade. His hypothesis was that there will be better understanding on the part of science group. Significant F-values were found on pupils' process measures for the experimental group. The success of SAPA, as compared to traditional science teaching, clearly lies in the area of improving cognitive and process-oriented skills. The study found that SAPA pupils had developed a more supportive attitude towards science as measured by Moore Sutman Attitude Inventory (MSAI).

Crocker (1976) and others studied the effects of different teaching strategies in the context of process-oriented elementary science activities and also the possible interaction between teaching strategies and other variables such as achievement of science process objectives preference for teachigg mode, sex, intelligence, creativity, personality and socio-economic status. The results of the study support the broad concept that different teaching strategies are effective for different types of students. This position is perhaps best articulated by Hunt (1971) who uses the term "matching models" to refer to the process of coordinating teaching strategies with pupil characteristics.

Vanek and Montean (1977) compared the effect of an activity-based curriculum in elementary science study and text book approach on student's ability of classification skills, science achievement, and scientific attitude. No measure of the actual differences in treatments was made.

The results of the study did not indicate difference in their classification ability, science achievement or attitudes of the third and fourth grade students.

Brown (1977) studied the effect of instruction in process skills on the ability of preservice elementary school teachers to perform on these skills in a written test. Analysis of variance for comparing the experimental and control groups on the post-test score yielded F-values which were significant at .05 level for treatment and interaction variables. It means that instruction, using a series of open laboratory activities, was strategically effective in teaching the processes of science to pre-service elementary school teachers. The t-values for both the experimental groups were also found to be significant at .001 level.

Pappelis and Pohlmann (1980), using the test of science processes as a pre and post-test, demonstrated improvement in the thinking skills of students of the Medical EducationaPreparatory Programme where SAPA or SAPA like activities were used in the curriculum. More specifically, significant improvement was made in the skills measuring, quantifying and inferring. No significant gains were made in other skills - observing, classifying, experimenting and predicting.

There were significant differences in class pretest scores. However all classes, with the exception of the third semester group, achieved significant gains in pre-test to post-test scores. It was concluded from these data that the level of ability to demonstrate intellectual skills were increased by the end of the course, irrespective of the level demonstrated at entry. Using the teachers for trails,

significant gains were found in the total test scores (F=12.07, df 133 p ∠ .01) and three of the eight subtests namely, quantifying (F=6.98, p ∠ .05), measuring (F=4.99 p ∠.05) and inferring (F=6.74, p ∠.05). Thus the null hypothesis that no improvement would be found in the process skills of students of Medical Education Preparatory Programme (MEDPPED), who had taken a SAPA like course in science processes, was rejected.

Berger (1982) studied attainment of skill in using science processes. Instrumentation, methodology, and analysis techniques were developed to measure the changes in adolescent skills in the estimation of linear distance. Micro-computers were used to present and control the amount of information available to assist students in estimation. Three different levels of difficulty in estimating were developed. The students estimated ten positions of a point on vertical line within each level of difficulty. Strategies used by students to estimate were found. A model was also developed, using regression analysis, to allow for the separation of variance of trend and individual skill differences. This model was used to predict decrease in number of estimates and decrease in average time per estimate. The number of estamates per position decreased rapidly and a limit was soon achieved. Thus average time per estimate was used as a measure of skill. Students improved their performance within the first two levels, but not within the most difficult level. Across levels, average performance improved inspite in increasing difficulty and a transfer effect appeared to take place ever time. It was concluded that micor-computers were valuable instrument for gathering and recording data. The model using regression

analysis was an effective tool to study estimation. Students used effective strategies and improved their estimation skill quickly. Learning did occur but the level of difficulty of information or practice effect available while solving an estimation problem may limit the extent of their improvement.

Padilla et-al (1984) studied different patterns and amounts of instruction on planning experiments by using a model for generating integrated process skill lessons. Results showed that both sixth and eighth grade students can learn to use certain integrated process skills. Growth was apparent in identifying variables and stating hypotheses.

Yeany et-al (1986) analysed the heirarchical relationships among modes of cognitive reasoning and integrated science process skills. Ordering theoretic and probabilistic latent structure methods were used to analyze date on five process skills and six logical reasoning skills collected from 700 science students. Both linear and branching hierarchical relationships were identified within and between the skills. It was found that most of them fit the logical hierarchies which have also influenced the curriculum development and classroom practices in the past. It was also found that a few of them ran counter to the existing logic and understanding of these skills.

Several other investigators studied the impact of materials and approaches upon the performance of pupils various stages of schooling. For example, Mayor and Livermore (1969) found that those children who start with SAPA in kindergarten do better in it at the intermediate levels than new corners. Similarly Douglass and Macbeth (1974) also found that kindergarten children who were involved in SAPA showed more extensive attainment of process skills than a control group. Ayers and Ayers (1973), who worked with

children in Appalachian mountain areas, found childrens readiness for reading by refering their abilities to use logic. Studies by Walbesser and Carter (1968) indicate that children of both advantaged and disadvantaged groups appear to perform equally well in the behavioural objectives of SAPA. Huff and Languis (1973), who worked with children from inner city schools in Columbus, Ohio, concluded that SAPA produced a positive effect upon the development of language output, vocabulary, general meaning and skills, sentence structure, word definition and listening behaviour.

Another important observation of the above investigators was as to how the process skills should be integrated into the school curriculum. Brief units devoted to integrated science skills were somewhat less beneficial than extended and large periods of instruction. It appears that integrated science process skills cannot best be taught as brief topics in the same way as topics of volcanoes or density. Instead greater benefits to students seem to result from integrated science content and process instruction over a longer period of time. The reference to any course of short duration for teaching science is likely to be less effective. This assumption would be tested in this project which, though, is limited in scope.

2.3 Process Based Instructional Material and Performance of Pre-service and Inservice Course Teachers.

Jaus (1975) investigated the direct effects of training of prospective elementary school teachers in the development of integrated science process skills. He concluded that achievement in integrated science process skills (ISPS) of prospective elementary school teachers can be significantly improved by studying self-instructional materials which provide instruction in the ISPS. His

finding supports the results of other studies related to basic science process skills (Ashley and Butts, 1972, Breit, 1971; Butts and Raun, 1969; Newport and McNeill, 1970). Preservice and inservice teachers who are provided training in the science process skills enable the children to attain competence. Thus it is a logical and first step towards the goal of producing teachers who are competent in these skills.

Brown (1977) investigated the effect of instruction in process skills on the ability of preservice elementary school teachers to perform on these skills in a paper and pencil situation. Statistically significant results supported the hypothesis that preservice elementary school teachers do learn to use the process of science as assessed by the Science Process Activities Test (SPAT). The pretest mean was found to be 14.24 and t-value of 8.44 (with df=82) was significant at .001 level. Further pre and post test means for another group (N=40) were ~~was~~ 11.77 and 14.32 respectively with t-value of 6.12 which was found significant at .001 level.

Campbell and Okey (1977) investigatdd the following problems :-

1. What influence does instruction have in process skills of pre-service teachers' achievement, selection of process objectives for science units, attitude towards process skills and the use of process objectives and activities in lesson plans.
2. Is there any relationship between pre-service teachers' open or closed mindedness and (i) achievement of science process skill, (ii) their attitude towards process skills; and (iii) then use of process skills in lessons planning.

The results indicated that (i) the teachers in the treatment group scored significantly higher on the process skill achievement test; (ii) they selected significantly more process skill objectives for science units; and (iii) they included significantly more process skill activities in their lesson plans. No significant differences were, however, found in the number of process objectives included in lesson plans and the attitude towards the use of process skills in elementary school science instruction. Significant correlations were found between process skill achievement and attitude towards process skills. The findings in the study support other studies (e.g. Jaus, 1972), that is, the preservice teachers may not acquire science process skill sin science course. Instruction of relatively short duration was sufficient to significantly alter their knowledge of process skills.

Bluhm (1979) observed the effect of science process skill instruction on preservice elementary teachers' knowledge of the ability to use and the ability to sequence science process skills. The experimental instruction consisted of a series of 'process models'. The process models are short instructor-guided, hands-on instructional activities which were designed to enable preservice elementary school teachers to gain knowledge of and develop the ability to use selected science processes (observing, inferring, hypothesis, making, hypothesis-testing, interpreting data and experimenting). The problem of this investigation was to determine whether pre-service teachers who have received science process skill instruction can significantly improve their process. In this regard Bluhm's study tends to support findings of Jaus (1975), Brown (1977), and Campbell and Okey (1977). That is, the process skill

achievement of preservice elementary school teachers can be and was significantly improved by prociding these future teachers with hands on activities designed to teach science process skills. One difference that might be noted, however, is that while previously cited researchers implemented self-instruction activities. Thus the researcher utilized an instructor-guided approach to teaching science processes.

2.4 Impact of SAPA on Science Text Books :

The third group of studies deal with the impact of several science projects (e.g. ESS, SCIS, SAPA). Perusal of the professional journals upon content of text books and periodicals in science education indicate that these projects, particular SAPA, led to the upgradation of science teaching and textual materials. David (1973) found that the more visible science text book improvements were noticed in the following two aspects :-

i) There was greater effort to improve the accuracy of scientific information;

ii) A discovery or laboratory-oriented approach was -apparent in more recent text books because of the greater emphasis on question and answer techniques rather than the dialogue or telling techniques which were so popular before the SC projects were introduced.

CHAPTER III

TEST OF INTEGRATED PROCESSES AND RELATED MATERIALS

3.1 INTRODUCTION

The chapter gives a brief review of the tests of integrated processes developed in other countries. These tests have been developed by keeping in view the particular criterion and the purpose of the project. One important feature of the integrated tests is that these are content free. It may also be mentioned that work in this direction was initiated after the launching of activity and inquiry -oriented curricular projects namely, ISCS, SCIS, ESS and SAPA. Under these projects, curriculum materials in the form of learning exercises, test items and several other aspect were developed. Self-learning process-based instructional material, as envisaged in the present project, was also developed. Simultaneously need was felt to prepare a test of selected integrated processes with a view to studying the effect of self-learning process based materials upon process skills. The basic assumption for preparing and administering the learning materials was that this will enhance pupils' scores on the process-based test items.

3.2 Tests of Integrated Processes (TIPS) : Development

The science process skills became more prominent in the classroom with the advent of new curriculula developed under several projects mentioned in Section 3.1 such as ESS, SCIS, ISCS and SAPA during sixties in the USA. Subsequently process-based test items were needed to assess students' achievement on science process skills.

Dillashaw and Okey (1980) provided an overview of process skills test development during 1960s and 1970s. Initially, these efforts aimed at specific science curricula. Investigators like Walbesser (1965), NcLeod et. al (1975) and Ludemann (1975) constructed process-based tests for the SAPA curriculum. Riley (1972) used SCIS for the development of another process-based test. Another group worked in the area of process tests which were not curriculum specific. These include the tests developed by Molitor and George (1976), Tannenbaum (1968) and Dillashaw and Okey (1980). These tests were developed keeping in view the need for a non-curriculum specific process skill tests for the middle and secondary school students. Tobin and Capie (1982) developed the test of Integrated Science Processes (TISP) which were designed for use from middle school stage to the college level. Lunetta, Hofstein and Giddings (1981) have suggested a criteria for systematic observations in order to assess the development of competence in process skills.

In view of the work done under the above mentioned projects for different stages of education under the project SAPA, an effort was made in the present project to prepare self-learning instructional materials based on selected integrated processes. Subsequently need was also felt to prepare a tool to assess the performance of students on process-based test items. Thus a process-based test of integrated processes was constructed by following the standard procedure. Normally the investigators (e.g. Tannenbaum, 1971) base each item

on a particular behavioural outcome but it is not always possible because there is considerable overlap in the learning outcomes relating to a particular process. Several items measure this effect to some extent.

3.3 Rationale of Items for the Science Process Test

Tannenbaum (1971) followed several criteria for the construction of his test of Science Processes (TOSP). The criteria included the following:

(i) The TOSP should concentrate exclusively on assessing students' ability to use a science process.

(ii) The TOSP drew its examples from several of the natural sciences and was shorter than is normally necessary for assessing "achievement in science " which is based on traditional subject demarcations.

(iii) While different methods of teaching may affect students' performance on the TOSP, different subject matter emphases should not.

The above considerations were kept in mind by the investigator of this project while developing items for the test of Integrated Processes in Science (TIPS). The TIPS was developed by observing the following steps:-

(i) Defining and stating, in behavioural terms, the science processes which were appropriate to the secondary school students. These statements, as stated in the previous section, were meant to serve as a kind of blue print for the TIPS.

(ii) Studying the school science texts and research reports to determine the processes of science which the secondary school students, espectially the ninth graders, were expected to use.

(iii) Reorganising, condensing, editing and stating in behavioural terms the statements of various processes. The behaviours to be covered under the TIPS were categorized under six processes: Classifying, Inferring, Interpretting, Predicting, Hypothesis-Making and Hypotehsis-Testing.

(iv) Determining curricular validity of the statements/components of the science processes by submitting these to a team of three science education experts. Drawing up a list of responses for each process on the basis of the judgements of experts.

(v) Pooling the responses for each item and drawing up a preliminary list of test items for the TIPS.

(vi) Trying-out the preliminary from the TIPS, and retaining items for the final form after following the procedure for the item selection.

The above steps, pertaining to the development of TIPS, are given in detail in the following sections.

4 Procedure Following the Development of TIPS

The following six process skill objectives, which formed the basis for making the test items, were identified :-

(i) Classifying
(ii) Inferring
(iii) Interpretting
(iv) Predicting
(v) Hypothesis-making
(vi) Hypothesis-testing

It was decided that the TIPS would concentrate exclusively on assessing students' ability to use science processes. As such the items were kept content free.

As mentiond earlier such an approach allows for the production of a test which draws its items from several of the natural sciences and knowledge of specific subject was not required as is generally expected in traditional tests of achievement in science.

The first step was to identify the statements in behavioural terms of science processes which were taken up for the study. These statements formed the basis for selecting test items for process-based test items. For this a number of science text books, teachers' guides and research reports were studied and reviewed. Learning outcomes in the form of behaviours under each process were also listed. These behavioural statements were submitted to three experts for studying the curricular validity ofthe statement of science processes.

In order that a student may demonstrate their competence in using the processes of classifying, inferring, interpretting, predicting, hypothesis-making and hypothesis-testing he should be able to do the following:-

Process I : Classifying :

(1) Group objects or system objects according to a given property.

(2) Select and justify an appropriate property and group objects or system of objects according to that property.

(3) Group objects or system of objects according to two simultaneous properties.

(4) Select and justify two or more appropriate simultaneous properties and group objects or system of objects according to these properties.

(5) Given a group of objects, identify the property or properties on which they are grouped.

(6) Given a set of objects or systems of objects, remove a specified number of members from the original set to form two new sets which are grouped on the basis of one or more given simultaneous properties.

Process II : Inferring :

(1) Arrive at generalisation from a body of data.

(2) Identify the factor most likely to have caused a given change in a system.

(3) Identify and specify observations which would be needed to justify a particular generalization.

(4) Be able to distinguish between a statement based directly on observations and one which is an inference or a generalization.

(5) Be able to draw more than one inference in situations where the data allows this.

(6) Recognize data that are necessary and sufficient to support an inference or a generalization.

Process III : Interpreting :

(1) Describe in a few sentences the information shown on a table of data or graph.

(2) Construct one or more predictions, inferences, or hypothesis from data given in tables, graps or pictures.

Process IV : Predicting :

(1) Be able to detect or demonstrate trends in data (presented in many different ways) and be able to use these trends to predict by extrapolation and/or intrapolation.

(2) Regonise and use pertinent argument, reason or Principle to justify a prediction.

(3) Devise and use simple means of checking the accuracy of the predictions made.

(4) Demonstrate an operational knowledge of the necessity for multiple and reliable observations prior to predictions.

Process V : Hypothesis-making :

(1) Construct a hypothesis, given a set of observations or inferences.

(2) Distinguish between inferences and hypotheses.

(3) Identify observations that support or do not support a hypothesis.

Process VI : Hypothesis-testing

Design an investigation appropriate to the problem:

(1) Select, clarify and state, in testable terms, the primary variable to be tested;

(2) Distinguish between dependent and independent variables;

(3) Control the appropriate variables so that logical conclusions may be drawn with regard to primary variables.

3.5 Pooling Test-items

In the beginning, forty eight items were written keeping in view the various components identified for the various processes. The items were of multiple choice type. Examples of two items having a bearing on two processes in given below by way of illustration.

Example : Process of Classification

In a box there are different types of buttons. Children are asked to classify these buttons into different groups. Children classified the buttons on the following criteria :

(1) On the basis of colour and shape

(2) On the basis of colour and number of holes.

(3) On the basis of colour shape, size, holes and quality of material of the buttons.

(4) On the basis of colour and size.

(5) On the basis of colour, shape, holes and quality of material of the buttons.

Examples II : Process of Hyepthesis -testing

Given above is a picture of a ball placed at the top of a slope. If you want to find out the average time it takes for the ball to roll all the way down the slope, about how many time should you let it roll down and time it?

(1) Once (2) 4 times (3) 15 times (4) 100 times (5) 250 times

A separate answer sheet was prepared which was used by the students to give responses for the TIPS to be used for the purpose of the study.

3.6 Try out : The test was administered on a sample of 390 students of class IX from four different schools of Bhopal city. The students were requested to attempt all the questions. 80% of students completed the test in one hour. If the students finished early, they were allowed to go back and work on any item which they had stopped because of difficulty in answering a particular item.

3.7 Item Selection for the Final Form of TIPS : Item analysis was done to select items for the final form of TIPS. For the purpose only 360 students out of the 390 students, who attempted all the test items, were included. Out of a total of 48 test items only those items were retained whose discrimination indices ranged between 0.20 and 0.54 As far the difficulty index, it ranged between 20 and

70 percent. Four items, whose discrimination indices were below 0.20, were dropped. Hence the final form of the TIPS consisted of 34 items. It may be stated that the mean item discrimination coefficient for the group test of science processes of a similar test developed by Tobin and Capie (1982) was found to be .32 and mean difficulty was estimated to be 0.42. Also Burne, Okey and Wire (1985), in their TIPS, had majority of the test items whose discrimination indices ranged between .20 and .60, with only one item having discrimination index of 0.80. Reliability index of the test, by split half method, was found to be 0.75. Both content and curricular validity of the test was ensured as due care taken in the construction the items. Content validity of the test was confirmed with the assistance of three judges. The judges were requested to match each item with the instructional ojectives selected from a set of objectives for each process. This technique employed is often referred to as "validation of experts".

3.4 SELF LEARNING PROCESS BASED INSTRUCTIONAL MATERIAL

3.4.1 Introduction : Science is a dynamic way to explore, validate and explain phenomena. It is not only a way of knowing the content and principles of knowledge but also a way of "doing". The "doing" emponent is identified with a series of processes or skills, there skills are not limited to just physical manipulation of objects, but involves mental op rations. Children explore their environment with curiosity. They look, smell, taste and hear as they interact with their environment. This doing respect has to do with a series of processes or skills. The acquisition of these skills makes the child active partner in the learning of science. Earlier to the launching of SAPA project by the American Association for the Advancement of Science (AAAS), the science was taught in a passive way with emphasis on concept learning. The basic approach of SAPA is that "children, even in the primary grades, will derive more from the study of science if they learn the behaviours of Scientists". Such behaviours in science have been identified and developed through a number of activities such as determining space/time relationships, symmetry shapes, classifying objects, interpretting data given in graphs. The SAPA has identified skills in two categories. The first category includes basic process skills such as observing, using space/time relationships, classifying, using numbers, measuring, communicating, predicting and inferring. The second category is known as integrated process skills and is built on basic process skills.

These skills to be emphasized from school to college level, include, controlling variables, defining operationally interpretting data, formulating hypotheses, and experimenting.

The integrated process skills can be developed through a 'series of activities'. The present research project was undertaken to develop these skills and judge them effectiveness by devising a test of integrated processes in science (TIPS) hich has been explained at length in the proceding section.

Format and Approach for Developing Process-based Materials:

In developing instructional materials, in the form of exercises and activities, science content is not as such specifically but is introduced in each activity. It is not specifically related to a particular scientific disciplin but is derived from familiar object and phenomena in childs' world'. The format followed by the original SAPA exercises was:

1. Stating objectives (in behavioural terms expected after completion of exercises)
2. Providing rationals and theoretical explanations about the selected processes
3. Providing vocabulary (words not used in previous exercises)
4. List of materials to be used
5. Originating problem (for arousing students interest in exercises to be discus ed)
6. Out lining instructional procedure (to be done in sequence since each skill/process builds on skills developed in preceding skills)

7. Appraising progress (to determine whether objectives have been attained)

4.3 Instructional Material Developed Under Project: The investigator followed a similar approach for developing self-learning instructional material for each of the sin processes taken for study under this project. For this purpose several types of teaching-learning materials developed by various study groups and persons were consulted. These included text books, workbooks, teachers' guide for inservice instruction, science magiznes, journals, Brown's Handbook of Science Process. Activities (1974) and other materials produced by the commission on Science Educator of the SAPA. Blanes (1963) investigations for the modern science and Pushu Swamy's were also consulted. Nuppiele's Foundations' textual material in physics, chemistry and biology were also consulted. Science text books used for different stages of school education in Madhya Pradesh were also consulted. As a first step, the student was introduced to the objectives and meaning of the process under study. Theory of each process was presented in the form of textual material. The next step was to write suitable exercises so that a student may be able to conduct some simple experiments, make observations and draw inferences. In some problems, the data was supplied and the students were required to interpret the same and make predictions on the basic of data. Further, some exercises the processes of hypothesis-making and testing were incorporated. The response sheets were inbuilt in the

material to be read by the students. This material was submitted to a group of 20 teachers in a workshop situation for finalization. The teachers were first oriented towards the approach and they worked on each module, discussions were held and final form was prepared after incorporating the necessary mofifications. Each student was given a set of the material in cyclostyled form to enable him to work out solutions for the exercises independently. The instructional material, based on the six processes, is given in Appendix B

CHAPTER IV

METHODOLOGY

4.1 Introduction : The chapter gives a short description of the various aspects used in the project which comprises of the sample, instructional materials administered for the development of science processes under study among the students, the test of integrated processes in science (TIPS), procedures of data collection, its analysis and interpretation. As this was primarily a research-cum-developmental project, the methodology used in the project was modified.

4.2 The Sample: For item analysis of the TIPS a sample of 390 was selected from four higher secondary schools of Bhopal city. But the response sheets of only 360 students, who attempted the test according to instructions were finally evaluated. Further in order to study the effect of process-based instructional material pre-testing, with the help of final form of TIPS, was done on a sub-sample of only 120, students of two higher secondary schools as administration of the materials on a large sample was not possible. As far as the nature of sampling, it was both a purposive and incidental. According to Guilfor (1956), 'a purposive sample is selected because there is good evidence that it is representative of the total population'. This could be ensured as the studnts came from different cross-sections of the society. The incidental sampling is done such cases which are 'the most available'. In the present study the schools selected represented the pupil population. Incidental sampling was justified in the sense in the project that the schools which were willing to cooperate in the

experiment of longer duration were selected. Random sampling was not possible in such a study. For the purpose of administration of instructional materials, that is, the treatment the "results were evaluated by pooling scores on criterion test in a single distribution fs all pupils under each method..... and the difference in means evaluated". (Lindguist, 1970,p.82)

4.3 Treatment and Post-testing : Each student was given for study the instructional material in the cyclostyled booklet, they were allowed to work at their own pace. It took the investgator nearly 3 months to complete the work in one school. The students were asked to study the materials under the supervision of the project investigator and JRF, they were not allowed to carry this material to their homes. After each session the material was collected back. The project staff supervised the progress of the students continuously. The students worked on simple exercises. Sometimes they worked in the data already provided and gave their interpretations. In other exercises the data was given and they were required to operate mutually. After each exercise feedback was given to the students to sustain their interest in the study. After the students completed their work on the instructional material, post-testing with the help of TIPS to tudy games, if any, in their scores on prowess skills. For final analysis, data of only 77 students who completed each aspect of the experiment was done. These 77 stuents of two schools were identical in the sense that they follow the CBSE

curriculum and their abilities are 'material' or equated. The purpose was not to study intergroup comparison but to assess the effectiveness of the process-based materials. Scoring of students' responses obtained after the post-testing on TIPS was done according to the scoring key prepared for the purpose.

4.4 Analyses of Data: Statistical techniques were used depending upon the nature of data. Discrimination indices and difficulty values were computed by using the standard technique. Product-moment correlations were computed for intercorrelations between the scores obtained on the six processes. Similarly use of t-test was made to study the game made by the students on pre and post test scores.

CHAPTER V
FINDINGS

5.1. INTRODUCTION

This chapter deals with findings of the study titled 'Xmkkx 'Developing, Validating and Testing the Efficacy of Self-Learning Process Based Material for the Development of Some Integrated Processes in Science'. Both qualitative and quantitative analyses have been done. In the qualitative analysis, occurence of behaviours on a particular component of science processes under study were analysed. The quantitative analysis comprised of intercorrelations between the scores on various applications of t-test for the pre and post test games. The intercorrelations were also used as an index of the TIPS validity. The games made by the students in the scores of various processes, from pre to post test situation under investigation were also studied. Interpretations of the results is given along with the findings. Lastly some implications of the study have been pointed out.

5.2. OBSERVATION OF LESSONS FOR PROCESS SKILLS

As mentioned earlier an observation schedule (Appendix A) was developed for recording the occurence of various components of the processrs in the lessons taught by the pupil teachers. Eighteen lessons were observed in all where the observer recorded the process based questions asked by the teachers in the course of their teaching science lessons in various subjects - Physics, Chemistry/ and Biology. As the process skills are not indluenced by the content, different subjects were covered. The type of questions asked reflected upon the different behaviours under each process. The analyses gave the investigator an indication whether a particular process skill was used by the pupil teachers or not during course of their teaching.

5.3. PROCESS SKILLS IDENTIFIED

A summary of the various skills under the six processes is given below:

(1) Inferring: Four behaviours identified for the process of inferring were (i) where the pupil teacher asks for one or more inferences from a set of observations, (2) identify observations that support an inference; (3) describes and demonstrate additional observations needed to test alternative inference; and (4) distingushes among inferences that should be accepted, rejected or modified on the basis of a additional observations. It was found that the occurence of first two behaviours was observed in all the eighteen lessons. The third behaviour was observed in 14 lessons whereas the last behaviour was observed in 13 lessons only.

II. Classifying : Behaviours identified for the process of classification were: (1) describes an object so that another person can identifythe object in a set of similar objects; (2) identifies and names observable properties of objectsin a set which could be used to classify the objects; and (3) constrycts one, two or more multi-stage classification of a set of objects and names the oberva-ble characteristics upon which the classification is based. It was found that the questions related to the first behaviour were asked by the pupil teachers in all the eighteen lessons. Behaviours related to the second and third were observed in 15 and 11 lessons respectively.

III. Predicting : Behaviours identified for the process of predicting were: (1) constructs a point graph usinf nymber pairs from qualitative observations, (2) identifies on a graph the manipulated variable and the responding behaviour; (3) distingushes between points on a graph that represents observations made by interpolating or extra-polating; (4) applies the rules for interpolating and

and extrapolating on a graph; and (5) orders a set of predictions on the basis of most to least confidence in them. It was observed that questions related to the above Behaviours occured in lessons 3, 2, 1, 1 and 1 respectively.

IV. Hypothesis-making : Behaviours identified for the process of hypothesis-making were: (1) distinguishes between inferences and hypotheses; (2) constructs a hypothesis from given a set of observations and/or inferences; (3) identifies test data which supports or do not support a hypothesis; and (4) constructs a revision of a hypothesis on the basis of additional data. It was observed that questions related to these behaviours occured in lessons 9, 11, 10 and 6 respedtively.

V. Interpretting Data : Behaviours identified for the process of interpreting were: (1) describes in a few sentences the information shown on a table of data or a graph; (2) constructs one or more predictions, inferences, or hypotheses from data in tables, graphs or pictures; and (3) applies a rule to determine the mean, median and range of a set of data; constructs predictions, inferences or hypothesesfrom this information. Except for the second behaviour in two lessons no other behaviour related to this particular process were observed.

VI. Experimenting : Four behaviours identified for the process of experimenting or hypotheses testing were: (1) constructs and demonstrates a test of the hypothesis; (2) describes how the data supports or does not support the hypothesis; and (3) constructs a revised hypothesis if the data do not support the original hypothesis. It was observed that questions related to the above mentioned behaviours occured only in lessons 4,5 and 4.

Interpretation: It may be concluded that the processes of prediction and interpretation hardly found any place in

in lesson plans and teaching. More commonly used processes were inferring, classifying.

The processes of hypothesis-formulating and experimenting were also not so commonly used as these should have been, keepin in view the objectives of teaching science at various stages of school education. Observa tion of lessons for whether the pupil teachers let the children develop their skills or not also reflect upon the need of such an instructional material where students and pre-service and inservice teachers are exposed to different activities, experiences and exercises so that they might attain objectives of science teaching at least partially.

5.3. INTERCORRELATIONS BETWEEN SCORES ON SCIENCE PROCESSES

Tannenbaum (1971) found product moment correlations between eight sub-processes namely, observing, comparing, classifying, quantifying, measuring, experimenting, inferring, predicting and total scores on these processes. Correlation coefficients found were 0.66, 0.58, 0.75, 0.78 0.88, 0.68 and 0.74 respectively. The investigator also computed the coefficients between the sub-processes selected for the present study, i.e. classifying, inferring, predicting, interpretting, hypothesis-making anf hypothesis testing and the totla scores on rest of the processes. The correlation coefficients found were 0.30, 0.50, 0.[illegible]0, 0.[illegible]5, 0.49 and 0.52. All these coeffi--cients were lower than those found by Tannenbaum, yet all these were at acceptable level of significance. These correlations between sub-scores and the rest of the processes confirm the validity of the test constructed.

Table 5.1. Inter-correlations Between Scores on the six Science Processes.

Science Process	Process (sub-scores) 1	2	3	4	5	6
1. Classifying	1.00	0.74	0.32	0.20	0.15	0.05*
2. Inferring		1.00	0.30	0.40	0.20	0.50
3. Predicting			1.00	0.15	0.29	0.10
4. Interpreting				1.00	0.30	0.20
5. Hypothesis making					1.00	0.30
6. Hypothesis testing						1.00

* Insignificant

Table 5.1 indicates that the correlation coefficient range between .05 and 0.74, the highest index of coefficient being between the processrs of inferring and classifying and lowest between classifying and hypothesis testing. It may be seen that 14 out of 15 correlation coeffi--cients are significant at .01 level (Snedecor and Cochran, 1968) which points out towards the conclusion that there is a certain degree of commonality between these mental processes.

5.4. POST TEST GAINS: EFFICACY OF INSTRUCTIONAL MATERIALS

After the students had gone through the instructional materials, post-test sessions were organised when the TIPS was administered again on the sampled pupil population with a view to studying the gains made, if any, in the mean scores on TIPS. This was followed by computation of Mean, SD, Correlation Coefficients and t-values for thr varuous sub-samples.

Table 5.2. gives the overall pre and post test mean scores obtained by the sampled pupil population on the TIPS. These scores are based on the performance of students on all the six processes. The TIPS, as mentioned earlier, has items components relating to the processes.

Table 5.2. Overall Pre and Post Test Means on TIPS

Group	N	M	SD	t
Pre-Test	77	15.96	3.97	*4.65
Post-test (Treatment)	77	19.33	4.96	

*Significant at .01 level for df=152.

t-value has been found to be 4.65 for df 152 which is significant at .01 level. The significant increase in scores indicate that pupils' performance on integrated processes can be enhanced by providing them self-learning materials in theform of exercises.

Table 5.3. Pre and Post Test Means on Each Process

	Pre-Test (N=77)		Post-test (N=77)		
Process	M	SD	M	SD	t
1. Classifying	5.08	1.68	6.01	1.32	7.15**
2. Inferring	3.66	1.62	4.52	1.78	6.84**
3. Predicting	2.96	1.50	3.88	1.72	7.66**
4. Interpreting	1.33	0.63	2.77	1.23	8.83**
5. Hypothesis-making	1.92	0.72	1.98	0.72	0.50
6. Hypothesis-testing	3.03	1.34	3.73	1.26	3.44

** p .01, df=152, * p .05, df = 152

Table 5.3 indicates that with the use of process-based instructional material, students made significant gains on all the processes except hypothesis-making. It may be that the instructional material was not sufficient enough to produce effect. Hypothesis-making requires a brain storming type of session where the participants may b encouraged to formulate answers, raise further questions make guesses in response to a problem.

Validity and Efficacy of the Process-based Material

On the basis of post-test differences after using the process-based instructional material it has been found out that t-test differences are significant in five out of the six processes. The t-values for hypothesis-making has not been found to be significant. It may be either due to insufficient exercises in the instructional material relating to this process or lesser number of test items related to process. It may be concluded that the instructional material is, on the whole, valid and effective for developing the various process skills amongscience students.

5.5. IMPLICATION AND SUGGESTIONS FOR FUTURE RESEARCH

Sample lesson plans and lessons of pre-service teachers were observed in order to assess how far pre-service teachers use different process skills while imparting instruction in science. It was observed that the prospective teachers do make use of the two processes namely classification and inferring. But the use of processes like predicting, interpreting, hypothesis-making and testing was negligible. We knew that in the elementary as well as secondary school curricula there is scope for the development of science processrs skills. As Jaus (1975) points out, "If a major goal of science education is to develop science process skills competence in children, logical first step towards the goal is to produce teachers who are competent in these skills." (p.445) If competence in science process skill includes the knowledge of science processes, the ability to sequence science processes as used in scientific problem-solving, then the "process model" strategy of

instructor-guided, hands on instruction appears to be an effective way to help pre-service teachers in acquiring the desired skills. Campbell (1979) compared the effectiveness of process skills instruction on reading comprehension of pre-service and in-service elementary teachers. The results of his study are important because they support the proposition that science process skills are strongly linked to the reading process. This implies that in the programme of pre-service and in-service education, the teacher educators should plan a variety of learning situation with a heavy emphasis on science process skills. It appears that skills which have been shown to influence the performance of teachers should certainly help them do a better job of providing worthwhile instruction to elementary and secondary children as well.

It may be concluded that students using similar instructional material based on the processes taken in this project as well as instructional material based on the rest of the processes may be taken up with pre-service teachers.

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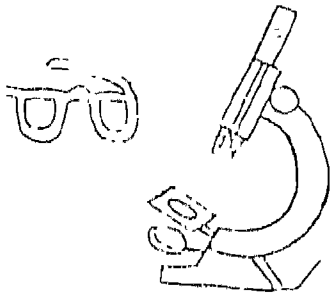
विज्ञान प्रक्रियाओं का परीक्षण

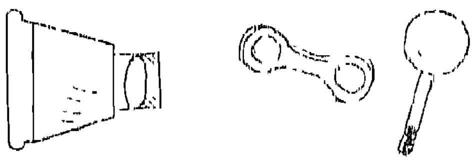
निर्देश :-

वैज्ञानिक अपने विषयक के अध्ययन में विभिन्न प्रक्रियाओं का प्रयोग करते हैं, और इन प्रक्रियाओं के आधार पर विज्ञान सम्बन्धित ज्ञान संग्रहित करते हैं। इस परीक्षण का उद्देश्य विज्ञान अध्ययन में प्रयुक्त प्रक्रियाओं से सम्बन्धित प्रश्नों पर आपकी उपलब्धि जानना है।

दिये गये प्रश्नों के उत्तर में आप अपने विचार स्वतन्त्रतापूर्वक प्रस्तुत कीजिये। प्रश्नों के नीचे उनके सम्भावित उत्तर दिये गये हैं, उनमें से उपयुक्त उत्तर का चयन कीजिये और उत्तर क्रमांक उत्तर पुस्तिका में प्रश्न खण्ड के सामने वाले खण्ड में लिखें जिन प्रश्नों में चित्र दिये गये हैं, उन्हें ध्यानपूर्वक देखकर उत्तर दीजिये। इस पुस्तिका पर आपको कुछ नहीं लिखना है। जो उत्तर पत्र आपको दिया गया है उसका उपयोग उत्तर देने के लिये कीजिये।

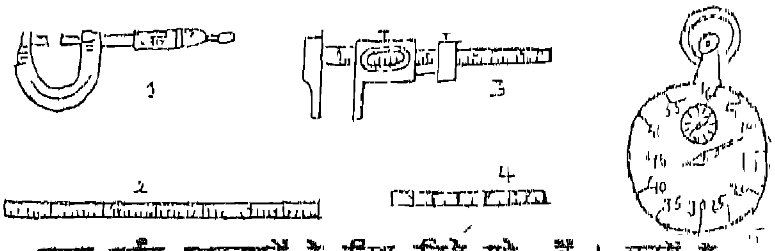
प्रश्न क्रमांक ।1। नीचे दिये गये चित्र में 5 वस्तुओं को दर्शाया गया है, इन वस्तुओं में विशेष रूप से एक समानता है। ये समानता कौनसी है?





।1। इनका आकार अलग-अलग है।
।2। दूर की वस्तुओं को देखने में सहायक होते हैं।
।3। ये सभी धातु से बनी हैं।
।4। उनमें लैंस हैं।
।5। उनके द्वारा वस्तुऐं छोटी दिखाई देती हैं।

प्रश्न क्रमांक ।2।



ऊपर पाँच उपकरणों के चित्र दिये गये हैं। इनमें से कौन सा उपकरण वर्ग विशेष का नहीं है?

।1। स्क्रू-गेज
।2। मीटर स्केल
।3। वर्नियर स्केल
।4। फुट स्केल
।5। घड़ी

प्रश्न क्रमांक (3) उपरोक्त दिये गये पाँच चित्रों का अध्ययन कीजिये और बताईये, कि इनमें कौन सा प्राणी अन्य चार प्राणियों से भिन्न है।

(अ) (ब) (स) (द)

(इ)

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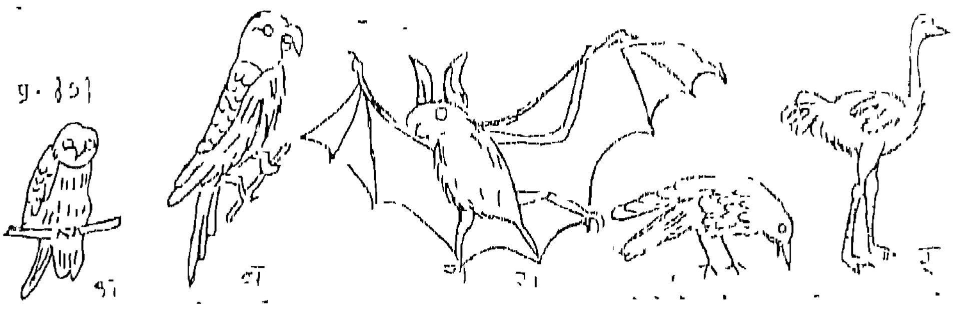
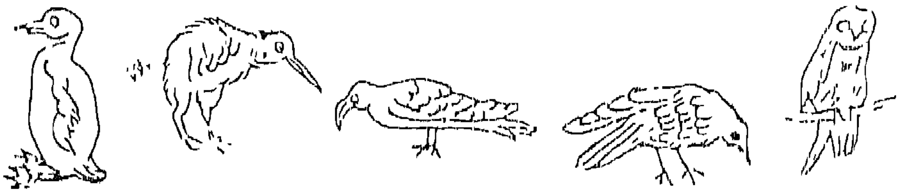


प्र. क्रमांक (4) नीचे कुछ पक्षियों के चित्र दिये गये हैं। इन चित्रों का सूक्ष्म अवलोकन करके पहिचानें कि कौन-कौन से पक्षी उड़ने वाले हैं, तथा कौन-कौनसे उड़ नहीं सकते? इनके क्रमांक आप अपने उत्तर पत्र पर दो खण्ड में लिखें।



(1) (2) (3) (4) (5)

प्रश्न क्रमांक 5 नीचे कुछ प्राणियों के नाम दिये गये हैं, जिनके वर्गीकरण के चरणों की रूपरेखा दी गई है। इसको ध्यान से पढ़िये और बताईये कि इनमें से कौन से चरण में गलत लगता है।

घोडा, गाय, गिद्ध बतख कुत्ता, बिल्ली सुअर, तोता, मुर्गी

	पालतु जानवर हैं	पालतु जानवर नहीं हैं
चरण (1)	घोडा, कुत्ता, बिल्ली मैना, तोता.	गाय, गिद्ध, बतख मुर्गी, सुअर
चरण (2)	पिंजडे में रखे जा सकते हैं मैना, तोता	पिंजडे में नहीं रखे जाते घोडा, बिल्ली कुत्ता

जिससे प्राय: हमें खाद्य पदार्थ मिलते हैं

मुर्गी, गाय, सूअर

जिससे प्राय: हमें खाद्य पदार्थ नहीं मिलते हैं

कुत्ता, बाघ, सिं, घोड़ा, बिल्ली

सवारी कर सकते हैं

घोड़ा

सवारी नहीं कर सकते हैं

बिल्ली कुत्ता

हाथी, सिंह, बाघ, सूअर

प्रश्न क्रमांक ।6। नीचे कुछ सफेद रंग के पदार्थों के वर्गीकरण की रूपरेखा दी गई है उसे ध्यानपूर्वक पढ़िए और बताइये कि कौन सा चरण आपको गलत लगता है ।

कुछ सफेद रंग के पदार्थ

खाने का सोडा, पाक चूर्ण, शक्कर चूर्ण, टेलकम पावडर, चाकचूर्ण

चरण ।1। पानी में घुल जाती हैं — पानी में अघुलनशील हैं ।

खाने का सोडा, पाकचूर्ण, शक्कर — चाकचूर्ण, टेलकम पावडर

चरण ।2। सिरके के साथ बुलबुले — सिरके के साथ बुलबुले नहीं उठते — सिरके के साथ बुलबुले उठते हैं — सिरके के साथ बुलबुले नहीं उठते ।

खाने का सोडा, पाकचूर्ण — शक्कर चूर्ण — चाकचूर्ण — टेलकम पाउडर

चरण ।3। पानी के साथ झाग देते हैं — पानी के साथ झाग नहीं देते हैं

पाक चूर्ण — पाक चूर्ण

प्रश्न क्रमांक ।7। एक बाक्स में विभिन्न प्रकार के बटन हैं । उन बटनों को

विभिन्न समूहों में वर्गीकृत करने के लिये बच्चों को कहा गया । बच्चों ने वर्गीकरण के लिये जो आधार अपनाये वे निम्नलिखित हैं । आपके विचार में वर्गीकरण का सबसे सही ढंग कौनसा है ?

।1। रंग और आकार के आधार पर

।2। रंग और बटन में छिद्रों के आधार पर

।3। रंग और आकार माप, बटनों के छिद्र तथा उनके पदार्थ के आधार पर

।4। रंग और आकार माप के आधार पर

।5। रंग, आकार, बटनों के छिद्र तथा उनके पदार्थ के आधार पर

प्रश्न क्रमांक ।8। दो जार "अ" और "ब" जिनका माप तथा आकार समान हो उन्हें आधा पानी से भर दिया गया । जार "अ" में छः तथा जार "ब" में बारह बर्फ के टुकड़े डाले गये । बर्फ के टुकड़ों का पूर्ण रूप से पिघलने के लिये जो समय लगा वह निम्न सारिणी में दिया हुआ है ।

।1। बर्फ के टुकड़ों की संख्या	।2। द्रवणांक का समय ।मि.।
जार "अ" 6	20
जार "ब" 12	60

आप अनुमान लगाये कि बर्फ के 9 टुकड़ों को इस परिस्थिति में पिघलने में कितना समय लगेगा ?

।1। 26.6 मि.

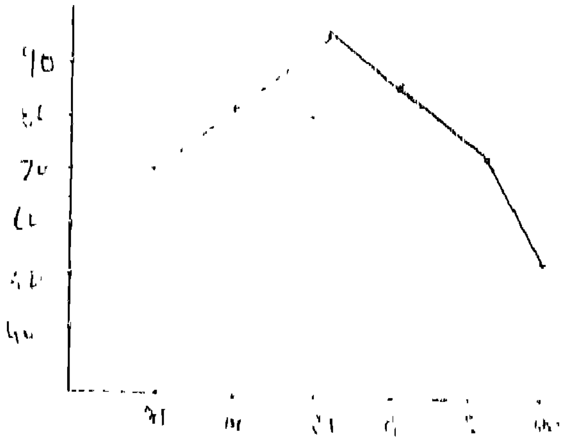
।2। 30.0 मि.

।3। 40.0 मि.

।4। 50.0 मि.

।5। उपरोक्त में से कोई नहीं .

प्रश्न क्रमांक 9 ग्राफ में पाँच द्रवों अ, ब, स, द, तथा ई के क्वथनांक बिन्दु दर्शाये गये हैं । ग्राफ देखकर बताओ कि कौन-कौन से दो द्रवों के क्वथनांक बिन्दु बराबर हैं ।



।1। "अ" और ब

।2। "अ " और स

।3। "ब" और द

।4। "द" और ई

।5। "अ" और द

प्रश्न क्रमांक 10

देश का नाम	औसत वर्षा (इंच प्रतिवर्ष)
अ	5.4
ब	56.7
स	63.1
द	95.4
ई	9.0

उपरोक्त चार्ट 5 देशों की वर्षा को दर्शाता है । किन देशों की सामान्य रूप से मरुस्थलीय है ।

।1। अ और ब

।2। ब और द

।3। ब और ई

।4। स और द

।5। अ और ई

प्रश्न क्रमांक (11) उपरोक्त चार्ट को पुनः देखें। नीचे इन देशों के विषय में कुछ अन्य तथ्यों की जानकारी दी जा रही है।

(अ) मिट्टी का उपजाऊपन

(ब) किसानों की संख्या

(स) फसल का मूल्य

(द) देश का क्षेत्रफल

(इ) औसत तापक्रम

उपर दी गई कौनसी जानकारी के आधार पर आप निर्णय लेंगे कि किस तरह के पौधे प्रत्येक देश में लगाये जा सकते हैं।

(1) ब केवल

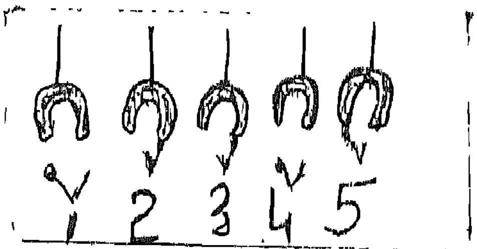
(2) अ, स और इ

(3) अ और ब

(4) स द और इ

(5) अ और इ

प्रश्न क्रमांक (12) नीचे दिये गये चित्र में पाँच चुम्बक तथा पाँच पिन दर्शाये गये हैं। नीचे दिये गये कथनों में से कौन कथन सिर्फ चित्र को देखते हुए नहीं किया जा सकता।



(1) दूसरे और पाँचवें पिन के सिरे मुड़े हैं।

(2) दूसरा और तीसरा, और पाँचवा पिन चुम्बकों से जुड़े हैं।

(3) कुछ पिनें ऐसी धातु की बनी हैं जो चुम्बकीय नहीं है।

(4) चित्र में वे पिनें जिनके सिरे मुड़े हैं चुम्बकों से जुड़ी हैं।

(5) पहला और चौथा पिन चुम्बक से नहीं जुड़े हैं।

प्रश्न क्रमांक (13) ऊपर दिये गये चित्र का पुनः अवलोकन कीजिये। यह सिद्ध करने के लिये कि दूसरा और पाँचवा पिन चुम्बक से आकर्षित होते हैं आप क्या करना चाहेंगे?

॥7॥

॥1॥ देखिये कि दूसरा और पाँचवा पिन चुम्बकीय है या नहीं ।

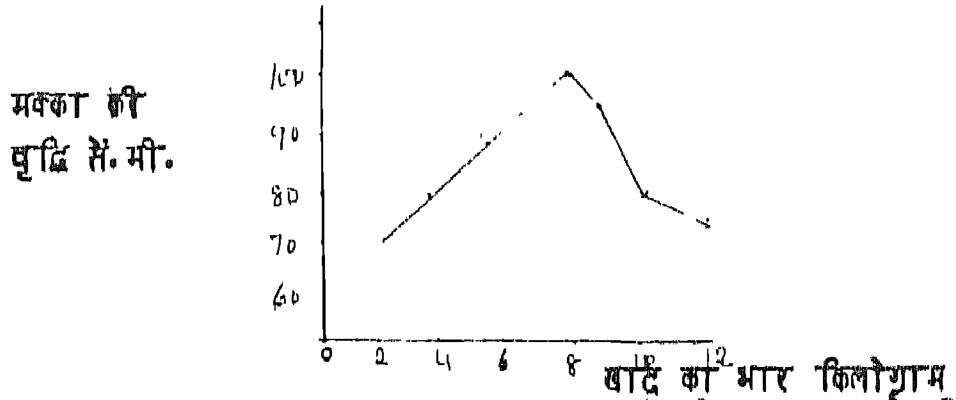
॥2॥ देखिये कि दूसरा और पाँचवा चुम्बक वास्तव में चुम्बक है या नहीं ।

॥3॥ एक अच्छा चुम्बक लेकर देखिये कि दूसरा और पाँचवा पिन एक दूसरे को आकर्षित करते हैं ?

॥4॥ ~~एक अच्छा चुम्बक लेकर~~ देखिये कि दूसरा और पाँचवा पिन ~~उनको~~ एक दूसरे को आकर्षित ~~होते~~ करते हैं या नहीं ~~होते हैं~~ ।

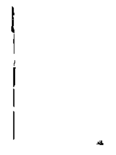
॥5॥ देखिये कि दूसरा और पाँचवा चुम्बक एक दूसरे को आकर्षित करते हैं ?

प्रश्न क्रमांक ॥14॥ एक प्रयोग यह अध्ययन करने के लिये किया कि जब खाद की मात्रा बढ़ाई जाती है तो मक्का की वृद्धि पर क्या प्रभाव पड़ता है ? प्रयोग पर आधारित आँकड़े नीचे दिये गये ग्राफ में दिखाये गये हैं ग्राफ का अध्ययन करके बताईये कि 9 किलोग्राम खाद डालने पर मक्का की वृद्धि कितनी होगी ?

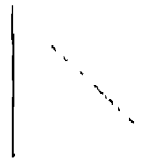


॥1॥ 70 सें.मी. ॥2॥ 85 सें.मी. ॥3॥ 90 सें.मी. ॥4॥ 95 सें.मी. ॥5॥ 100 सें.मी.

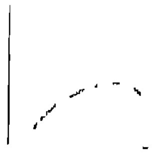
प्रश्न क्रमांक ॥15॥ एक अध्ययन में पाँच समान प्रकार के खेतों में विभिन्न मात्रा में उर्वरक डाले गये हैं और एक माह बाद उनमें उगाये गये पौधों की औसत ऊँचाई मापी गई । विभिन्न ग्राफ द्वारा माप दर्शाए गए । कौनसा ग्राफ आँकड़ों की पुष्टि करता है ।



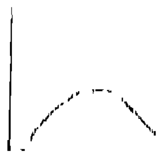
।अ।
(1)



।ब।
(2)



।स।
(3)



।द।
(4)

उर्वरक की मात्रा	पौधेम की औसत ऊँचाई
10	7 से. मी.
30	10 से. मी.
50	12 से. मी.
80	14 से. मी.
100	12 से. मी.

प्रश्न क्रमांक ।16। " जितनी ऊँचाई से कोई रबर की गेंद नीचे गिराई जाती है उतनी ही वह अधिक उपर उछलती है ।" इस प्राकल्पना में की पुष्टि निम्न में से कौन से आँकड़े करते हैं ?

।अ।
(1)

धरातल से ऊँचाई	उछाल	धरातल
25 से. मी.	5 से. मी.	लकड़ी
50 से. मी.	10 से. मी.	लकड़ी
75 से. मी.	15 से. मी.	लकड़ी
100 से. मी.	20 से. मी.	लकड़ी

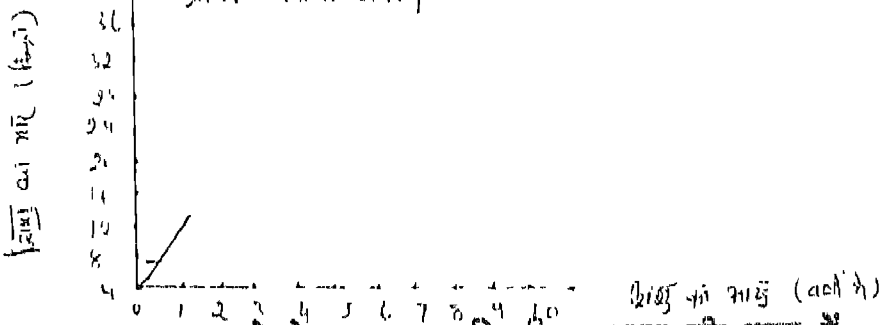
।ब।
(2)

धरातल से ऊँचाई	उछाल	धरातल
50 से. मी.	10 से. मी.	लकड़ी
50 से. मी.	5 से. मी.	दरी
50 से. मी.	48 से. मी.	गद्दा
50 से. मी.	40 से. मी.	मिट्टी

।स।
(3)

धरातल से ऊँचाई	उछाल	धरातल
25 से. मी.	5 से. मी.	लकड़ी
50 से. मी.	10 से. मी.	लकड़ी
75 से. मी.	12 से. मी.	लकड़ी
100 से. मी.	08 से. मी.	लकड़ी

प्रश्न क्रमांक ।17। ग्राफ को देखिये । यह दर्शाता है कि जैसे जैसे शिशु की शारीरिक वृद्धि होती है उसका भार बढ़ता है शिशु का भार जन्म के समय, 6 तथा 12 माह की आयु में मापा गया । आँकड़ों के आधार पर निम्न ग्राफ लगाया गया ।



ग्राफ को देख कर बताईये कि 9 माह की आयु में बालक का भार कितना होगा ?

।अ। 8.5 किलो

।ब। 9.0 किलो

।स। 11.0 किलो

।द। 12.0 किलो

प्रश्न क्रमांक ।18। ऊपर दिये गये ग्राफ को ही अध्ययन करके बताईये कि 2 वर्ष की आयु में बालक का भार कितना होगा ?

।अ। 15.0 किलो

।ब। 17.0 किलो

।स। 20.0 किलो

।द। 22.0 किलो

प्रश्न क्रमांक ।19। एक छड़ को गर्म किया गया और विभिन्न तापक्रम पर उसकी ~~ऊँचाई~~ लम्बाई नोट की गयी । अध्ययन के आधार पर तापक्रम और छड़ की लम्बाई को निम्न तालिका द्वारा दर्शाया गया । तालिका का अध्ययन करके बताओ कि 60 से.ग्रे0 पर छड़ की लम्बाई क्या होगी ?

[illegible]	50 से.ग्रे.	[illegible]
[illegible]	100 से.ग्रे.0	[illegible]

।1। 102.5 से.मी.

।2। 103.0 से.मी.

।3। 104.0 से.मी.

।4। 10[illegible].5 से.मी.

प्रश्न क्रमांक ।20 उपरोक्त तालिका को पुनः ध्यानपूर्वक देखो और बताओ कि 100 से.ग्रे. पर सम्भावित लम्बाई क्या होगी ?

।1। 103.5 से.मी.

।2। 104.5 से.मी.

।3। 104.0 से.मी.

।4। 105.0 से.मी.

।5। 105.5 से.मी.

प्रश्न क्रमांक ।21। सर्कस में रस्सी या तार पर चलती हुई लड़कियां अपने हाथ में खुला छाता रखती हैं ।

।1। लड़कियों का भार बढ़ाने के लिये

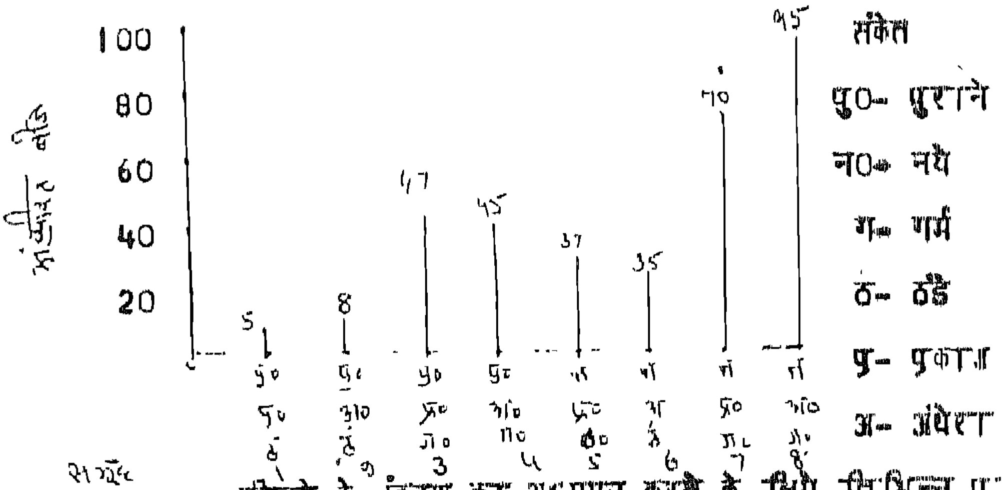
।2। उनके गुरुत्वकेन्द्र तार के ऊपर ठीक रखने के लिये

।3। उनका गुरुत्वकेन्द्र तार के नीचे रखने के लिये

।4। गुरुत्वाकर्षण को बढ़ाने के लिये

।5। सुन्दर लगने के लिये ।

प्रश्न क्रमांक ।22। प्रत्येक समूह में 100



बीजो के अंकुरण का अध्ययन करने के लिये विभिन्न परिस्थितियों में किये गये एक प्रयोग में आंकड़ों के आधार पर उपयुक्त ग्राफ प्राप्त हुआ इस प्रयोग में 400 बीज 10 साल पुराने तथा 400 नये बीज को उपयुक्त मिट्टी में बोया गया । इनकी प्रत्येक दिन पानी से सिंचाई की गई । अध्ययन के लिये प्रयोग को निम्न चार समूहों में बांटा गया ।

।1। 100 पुराने बीज 100 नये बीज अंधेरे तथा ठंडे स्थान पर रखे.

।2। 100 पुराने बीज तथा [illegible] नये बीज प्रकाश तथा ठंडे स्थान पर रखे गये।

॥3॥ 100 पुराने बीज तथा 100 नये बीज अंधेरे तथा गर्म स्थान पर रखे गये ।

॥4॥ 100 पुराने तथा 100 नये बीज प्रकाश तथा गर्म स्थान पर रखे गये ।

पांच कारक सामान्य रूप से बीज के अंकुरण और वृद्धि पर प्रभाव डालने वाले हैं - पानी, तापक्रम. मिट्टी बीज की आयु तथा प्रकाश । इनमें से किन-किन का परीक्षण किया गया ।

॥1॥ ताप, बीज की आयु और प्रकाश

॥2॥ मिट्टी ताप और प्रकाश

॥3॥ ताप मिट्टी और बीज की आयु और प्रकाश ।

॥4॥ पानी और मिट्टी

॥5॥ पानी और बीज की आयु

प्रश्न क्रमांक ॥23॥ उपरोक्त दिये गये ग्राफ को पुनः देखो ग्राफ का अध्ययन करने पर जानकारी प्राप्त होती है ।

॥अ॥ 365 बीजों का अंकुरण हुआ ।

॥ब॥ 400 बीज 10 साल पुराने है ।

॥स॥ 400 बीज नये हैं ।

॥द॥ 400 बीज ठण्डे स्थान पर रखे गये ।

॥ई॥ 400 बीज गर्म स्थान पर रखे गये ।

॥क॥ 400 बीज प्रकाश में रखे गये ।

॥ख॥ 400 बज अंधेरे में रखे गये ।

कौन सी जानकारी अन्य के कारण प्राप्त होती है ?

॥1॥ ॥अ॥ ॥4॥ (द) ॥6॥ (क)

॥2॥ (ब) ॥5॥ (ई) ॥7॥ (ख)

॥3॥ (स)

प्रश्न क्रमांक ॥24॥ ग्राफ को पुनः देखिये । उपरोक्त प्रयोग से संबंधित निम्नलिखित पांच कथन दिये गये हैं -

॥अ॥ पुराने बीजों की तुलना में नये बीज अधिक अंकुरित हुए

॥ब॥ कितने बीज के अंकुरित होने पर ताप का इस पर प्रभाव पड़ता है ।

॥स॥ कितने बीज अंकुरित होते हैं इस पर प्रकाश का प्रभाव पड़ता है ।

॥द॥ कितने बीज अंकुरित होते हैं जिस पर पानी का प्रभाव नहीं

उपरोक्त ग्राफ से आपको निम्नलिखित में से कौन सी जानकारी मिल सकती है ।

(1) अ केवल

(2) अ, ब और स द केवल

(3) द और इ केवल

(4) स और द केवल

(5) अ, ब और इ केवल

प्रश्न क्रमांक (25) ग्राफ को पुनः देखो । नीचे कुछ अन्य प्रयोग दिये गये हैं, जिन्हें आप कर सकते हैं । इन प्रयोगों में से ~~एक~~ एक प्रयोग ऐसा है जो ग्राफ में दर्शाये गये प्रयोगों में से नहीं है।

(1) बीजों की आयु का अध्ययन करना ।

(2) बीजों पर विभिन्न घण्टों प्रकाश तथा अंधेरे का ~~अध्ययन~~ प्रभाव का अध्ययन .

(3) पौधों की ऊँचाईयों का अध्ययन .

(4) बीजों पर पानी की विभिन्न मात्रा के प्रभाव का अध्ययन करना।

(5) बीजों पर विभिन्न तापों के प्रभाव का अध्ययन .

प्रश्न क्रमांक (26) ग्राफ को पुनः देखो 800 बीजों का ही उपयोग क्यों किया गया ? । निम्न कथनों में से सही चुनो ।

(1) 800 ~~80~~ बीजों से 100-100 बीजों (एक राउंड संख्या) के आठ समूह बनते हैं जो कि एक पूर्ण संख्या है ।

(2) प्रयोग के लिये प्रत्येक समूह में केवल 100 बीजों का ही उपयोग हो सकता है ।

(3) केवल 800 बीज उपयोग के लिये उपलब्ध थे ।

(4) समूह इतने बड़े हों जिससे सम्भवतः गलतियाँ कम हों ।

(5) थैले में से 800 बीज ही निकाले थे ।

प्रश्न क्रमांक ।27। वैज्ञानिकों ने यह प्राकल्पना बनाई कि "अ" और "ब" दूसरे के प्रभावित कर मादा की एक विशेष ग्रन्थि "स" को सुचारू रूप से कार्य करने के लिये महत्वपूर्ण ग्रन्थियाँ है । निम्नलिखित में से कौन सा अवलोकन उपरोक्त प्राकल्पना की सबसे अधिक पुष्टि करता है ।

।1। ग्रन्थि "ब" को हटा देने से "स" ग्रन्थि अविकसित रहती है ।

।2। ग्रन्थि "अ" को हटा देने से मृत्यु हो जाती है ।

।3। ग्रन्थि "ब" हारमोन्स स्त्रावित करती है ।

।4। ग्रन्थि "अ" अन्य कई अंगो का नियन्त्रण करती है ।

।5। ग्रन्थि "स" का विकास तभी होता है जब ग्रन्थियाँ "अ" और "ब" दोनों उपस्थित हों ।

प्रश्न क्रमांक ।28। निम्नलिखित में से कौन से विधि उपरोक्त प्राकल्पना का अध्ययन करने के लिये सबसे उपयुक्त होगी ।

।1। ग्रन्थि "अ" के समान कार्य करने वाले सभी ग्रन्थियों का परीक्षण किया गया ।

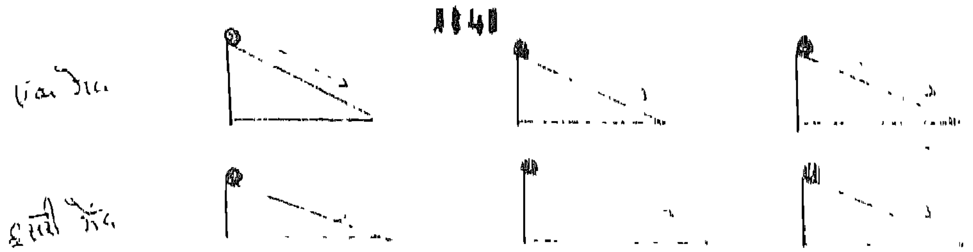
।2। ग्रन्थि "अ" और "ब" से स्त्रावित होने वाले हारमोन्स का तुलनात्मक अध्ययन किया जाये ।

।3। समान परिस्थितियों में "अ" और "ब" से स्त्रावित हारमोन्स की मात्रा का अध्ययन किया जाये ।

।4। यह अध्ययन किया जाये कि जब ग्रन्थि "स" में ग्रन्थि "अ" और "ब" से विभिन्न मात्रा में हारमोन्स इंजेक्शन के द्वारा पहुँचाए जाते है तो क्या होता है ?

।5। ग्रन्थि "स" के होने वाले परिवर्तन का प्रतिदिन अध्ययन किया ~~न~~ जाये ।

प्रश्न क्रमांक ।29। मान लीजिये कि आपको दो गेंद दी गई है और आपको बताया गया है कि इनमें से एक खोखली है तथा दूसरी ठोस है परन्तु आप इन्हें केवल देखकर यह नहीं बता सकते कि कौनसी खोखली है तथा कौन सी ठोस । पता लगाने के लिये इनमें से कौनसी खोखली है तथा कौनसी ठोस नीचे दिये गये प्रयोग में से कौन सा प्रयोग कर समस्या का हल निकाल सकते है



प्रयोग (1) प्रयोग (2) प्रयोग (3)

(अ) प्रयोग (1)

(ब) प्रयोग (2)

(स) प्रयोग (3)

प्रश्न क्रमांक (30) एक व्यक्ति ने यह जानकारी दी कि उसको एक गम्भीर बीमारी/ई से मुक्त करने के लिए एक ओझा ने ऐसे पौधे का उपयोग किया जिसकी जड़ें सर्पगंधा (   ) पौधों की जड़ों से बहुत कुछ मिलती है।

इस जानकारी के आधार पर बनाई गई निम्नलिखित प्राकल्पना में से आप किस को सबसे अधिक उपयुक्त समझते हैं।

(अ) पौधा अनुपयोगी है क्योंकि ओझा प्रशिक्षित चिकित्सक नहीं था।

(ब) पौधा अनुपयोगी है, क्योंकि वह व्यक्ति यह ज्ञात नहीं कर सका कि वह पौधा उसकी बीमारी दूर करने में कितना प्रभावशाली था।

(स) पौधा शायद सहायक रहा होगा। क्योंकि उस व्यक्ति को ओझे द्वारा इलाज करने के बाद लाभ हुआ।

(द) पौधा उपयोगी है क्योंकि प्राप्त विवरण के अनुसार रेजस्पाइन एक ऐसी दवा है, जो ब्लडप्रेशर को कम करती है। और यह सर्पगंधा से बनाई जाती है।

प्रश्न क्रमांक (31) सर्पगंधा जैसे पौधे के औषधीय गुणों का प्रारम्भिक अध्ययन करने के लिये निम्नलिखित में से कौन सा परीक्षण सबसे उपयुक्त होगा?

(अ) पौधे के एक भाग को लेकर उसका प्रभाव मनुष्यों पर नियन्त्रित स्थिति में देखा जाये, और प्रभाव का विवरण तैयार किया जाये।

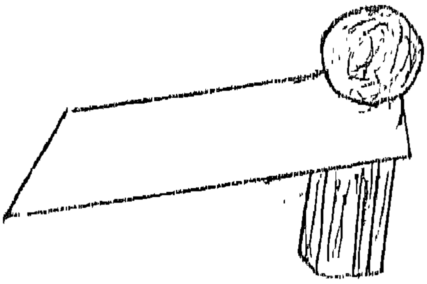
(ब) पौधे प्रभाव को अध्ययन करने के लिये चूहों के दो समूह लिये जाएं, जिनमें से एक प्रायोगिक तथा

दूसरा निर्धारित समूह हों ।

(स) उस पौधे की बनाई दवा दुनियाँ के सैकड़ों चिकित्सकों को भेजी जाये, जिससे जिन व्यक्तियों पर दवा का प्रभाव अध्ययन के लिये प्रतिदर्श । । किया जाये कि वे एक दूसरे से किस प्रकार सम्बन्धित है ।

प्रश्न क्रमांक (32) नीचे चित्र में एक गेंद नत तल । । पर दर्शायी गयी है । यदि आप यह ज्ञात करना चाहते हैं कि गेंद को नत तल के शिखर से नीचे पहुँचने तक कितना औसतन समय लगेगा तो कितनी बार गेंद को शिखर से लुढ़काकर समय नोट करना चाहिये ।

(अ) 2
(ब) 4
(स) 15
(द) 25
(इ) 75



प्रश्न क्रमांक (33) तीन परखनलियों में द्रव भर कर एक गोली समान वस्तु दोनों में डाल दी गई । परखनलियों के मुँह पर रबर के ढक्कन से कस कर बन्द करके एक लकड़ी की तख्ती जिसमें 3 छिद्र है [illegible] कर उलटा कर दिया गया । गोलियाँ द्रव में भिन्न-भिन्न गतियों से नीचे आईं । अवलोकन के आधार पर कौनसी प्राक्कल्पना सबसे उपयुक्त लगती है ?

(1) परखनलियों में द्रव समान हैं ।

(2) दोनों परखनलियों में द्रव भिन्न-भिन्न है ।

(3) जिस परखनली में द्रव भारी है उसमें गोली धीरे-धीरे नीचे आयेगी ।

(4) जिस परखनली में द्रव हल्का है उसमें गोली धीरे-धीरे नीचे आयेगी ।

प्रश्न क्रमांक ।36। पौधे कितना भोजन बनाते हैं इसका अनुमान उनमें बनने वाली स्टार्च की मात्रा से लगाया जा सकता है । इसका अध्ययन करने के लिये एक प्रयोग करते समय प्रकाश, कार्बन-डाय-आक्साइड तथा पानी की मात्रा में परिवर्तन किया जा सकता है । निम्नलिखित में से किस प्राक्कल्पना का अध्ययन करना अधिक उचित होगा ।

।अ। पौधों को जितना कार्बन-डाय-आक्साइड की मात्रा ज्यादा मिलती है उतना ही प्रकाश की आवश्यकता अधिक होती है ।

।ब। पौधे जितनी अधिक स्टार्च बनाते हैं उतनी ही अधिक प्रकाश की उनमें आवश्यकता होती है ।

।स। पौधों को जितना अधिक पानी मिलता है उतनी ही अधिक कार्बन-डाय-आक्साइड की आवश्यकता पड़ती है ।

।द। पौधों को जितना अधिक प्रकाश मिलता है वे उतनी ही अधिक कार्बन-डाय-आक्साइड पैदा करते हैं ।

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हर [illegible] शरि,

[illegible] दन्नै एन